FGC - 670.1 (3/94)

A PETITION TO THE STATE OF CALIFORNIA
FISH AND GAME COMMISSION

For action pursuant to Section 670.1, Title 14, California Code of Regulations (CCR) and Sections 2072 and 2073 of the Fish and Game Code relating to listing and delisting endangered and threatened species of plants and animals.

I. SPECIES BEING PETITIONED:

Common Name: Lime Ridge Eriastrum

Scientific Name: Eriastrum ertterae

II. RECOMMENDED ACTION:

(Check appropriate categories)

a. List X b. Change Status

As Endangered X from _____

As Threatened ___ to _____

Or Delist ___

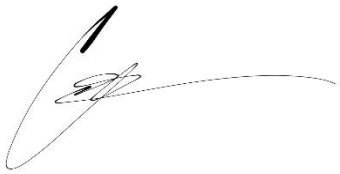
III. AUTHOR OF PETITION:

Name: Christopher McCarron

Address: [redacted]

Phone Number: [redacted]

I hereby certify that, to the best of my knowledge, all statements made in this petition are true and complete.



Signature: _____

Date: 7/6/2021

FGC - 670.1 (3/94)

A PETITION TO THE STATE OF CALIFORNIA FISH AND GAME COMMISSION

SUPPORTING INFORMATION FOR:

Lime Ridge Eriastrum (*Eriastrum ertterae)*

Fig. 1- Picture of *Eriastrum ertterae* in full bloom.

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Fig. 2- Scale comparison of *E. ertterae* to a one-dollar coin

EXECUTIVE SUMMARY

The Lime Ridge Woolly Star (*Eriastrum ertterae* D. Gowen) is an annual wildflower in the Phlox family (Polemoniaceae) that was described in 2013 by David Gowen (Gowen 2013). It is known from only two element occurrences on Lime Ridge Open Space in Walnut Creek, Contra Costa County California (CNDDB, 2018). Between May 20th and May 23rd of 2018 a complete census was done using a ½ meter quadrat along with a measuring tape to record the precise square footage of the area in which *E. ertterae* grows. The surveys counted 1,297 individuals growing in a combined area of 17.16m². Subsequent visits were done on June 6, 12, 18 and July 12 of 2018 to look for additional populations of the species. One new colony was found.

The species has only two known element occurrences comprised of 4 small colonies (colony A, B, C, & D; see Fig. 8, 9, 10 & 11), all of which are located within Lime Ridge Open Space (CNDDB, 2018). Areas of Lime Ridge are composed of an unusual calcareous soil. Grazing pressure from rabbits and other small mammals who don't stray far from the cover of shrublands contributes to barren ecotones between chaparral and grassland habitat (Fig 5). *E. ertterae* is found only in barren areas that occur on the calcareous substrate. Suitable habitat for *E. ertterae* is therefore fragmented and isolated, with no adjacent areas available for expansion. Invasive species, land use issues, and natural disturbance regimes present a threat to all known occurrences of the species.

The northern Element Occurrence (EO) on the ridge (EO 1) is the most threatened, as most of its area is located along hiking trails. There are three colonies (colonies B, C, & D) that total 6.35m², with most of the 150 individuals found in 2018 subjected to regular foot traffic, mountain bike activity and disturbance due to PG&E maintenance work and brush removal for fire clearance. One colony (colony B) occurs adjacent to a PG&E transmission tower along a trail (Fig. 11). In years prior to 2018, colony B typically had a few hundred plants observed scattered along the side of the trail (communications with David Gowen). In 2018, only a single individual was found in the suitable habitat where this stand typically occurs. Subsequent visits in 2019 and 2020 found no individuals. A large pile of cleared brush was cached in suitable habitat as a product of PG&E's efforts to remove brush from under the transmission tower.

There are two other colonies within this EO that occur farther off the main trail (colonies C & D) (Fig. 11). One has a non-sanctioned trail adjacent to it, and both have underground gas lines in close proximity. Any future gas line maintenance could pose a threat. The presence of invasive species in the northern EO also poses a serious threat in this location. Tocalote (*Centaurea melitensis*) is of concern because it forms monotypic stands within portions of the barren ecotones along the ridge (Fig. 21 & 22). Tocalote is sub-dominant in all the colonies on the northern end of the ridge and without

actions to control its spread it could establish a monoculture in which *E. ertterae* would be extirpated. Further degradation of the three colonies making up the northern portion of EO 1 is of very serious concern, and immediate steps are necessary to avoid the complete extirpation of this occurrence.

It should also be noted that in early July of 2018, a fire broke out in the northern area of Lime Ridge that burned within 10m of the most northern colony of EO 1 (colony D) which was home to 56 individual plants. This species' response to fire is unknown, but given that it grows in barren areas, traditionally fires would not have burned extremely hot in its microhabitat. With the increase of invasive plants moving into barren ecotones, the fuel load of the surrounding area will increase causing fires to burn hotter and longer (Rocca 2009). The creation and maintenance of future fire breaks along the ridge also threatens *E. ertterae,* because disturbance of vegetation and soil could destroy current or future habitat for the species.

The southern EO (EO 2, colony A) is located far off trails (Fig. 11). A total of 1,147 individuals were documented in 2018 at colony A, in an area totaling 10.81m², making it the largest colony and EO. While threats to this EO are less severe than those observed at the northern EO (EO 1), impacts from invasive species, such red brome (*Bromus madritensis),* should be monitored continually. This is the only location where the population is subjected to minimal disturbance and is not found in close proximity to trails or infrastructure that could threaten the species. A management plan for this EO must be developed in order to ensure its protection.

Several factors are a concern for the long-term conservation of this species. Small population size, limited suitable habitat, invasive species, land use changes and the role of disturbance regimes each need more attention. Being listed as a state endangered species is a necessary step toward ensuring this species does not go extinct. Additional steps must be taken to ensure that populations can expand and so that new occurrences may be introduced in suitable habitats at Lime Ridge in the future.

TAXONOMY & DESCRIPTION

TAXONOMIC HISTORY

According to De Groot (2016), the first four species of *Eriastrum* were described by George Bentham in 1833 but published under a new genus, *Hugelia*, which he later abandoned when he lumped them into the genus *Gilia.* The species that were to become *Eriastrum* resided within *Gilia* until 1907 when August Brand lumped all of these taxa with *Navarretia.* This taxonomic change was not adopted widely. In subsequent years, researchers concluded that because *Hugelia* was a later homonym used by Bentham, it should be considered an illegitimate name. Thus in 1913, the

genus *Eriastrum* was erected by Elmer Wooten and Paul Standley to fill the void of a legitimate name for the genus. However, publications continued to treat species of *Eriastrum* as different genera, with botanists such as Willis Jepson using *Hugelia* in his *Flora of California* in 1943, and Thomas Craig (a student of Philip Munz) treating them within *Gilia* subgenus *Hugelia* in 1934. In 1945 Herbert Mason published his taxonomic revision, with species treated in *Eriastrum*. Later in 1959, 1968, and 1972, H. Keith Harrison went on to publish other revisions, also treating them as *Eriastrum.* The genus is now commonly recognized as being endemic to western North America with a total of 18 species and 14 subspecies for a total of 32 taxa currently recognized (De Groot 2016). One of its more recent additions includes the Lime Ridge Eriastrum (*Eriastrum ertterae*), which was formally described by David Gowen in 2013.

In 1998, Barbara Ertter observed seeds collected from desiccated plants at Lime Ridge that resembled *Eriastrum hooveri.* However, researchers did not consider this collection a novel taxon until 2003 when David Gowen came across it while trying to find *Navarretia gowenii*, which he would eventually describe as a new species as well. The holotype of *E.ertterae* was collected on July 1, 2005 (*Gowen 471*, holotype: JEPS; isotype: BRY) (Gowen 2013). *Eriastrum ertterae* did not fit any existing species in *Eriastrum* but was determined to be morphologically similar to *E. hooveri*, which occurs, at its closest location, 160 km south of Lime Ridge. During subsequent years, Gowen conducted additional field work, morphological comparisons, and common garden experiments. He came to conclude that there were phenological barriers to gene flow between *E. hooveri* and *E. ertterae* due to the fact that *E. ertterae* flowers a month later than *E. hooveri.* These two taxa also have different morphological characteristics, with regards to flower size and color, another position, and stamen size and position. These differences along with the fact that the two species have expansive geographic barriers led Mr. Gowen to formally describe the species in the *Journal of Botanical Research Institute of Texas* (Gowen 2013). *The Jepson Manual* (Baldwin 2012) and De Groot (2016) recognize *E. ertterae*.

DESCRIPTION

Based on De Groot's (2016) description, *E. ertterae* is an:

Annual herb, 1.5–20 (–25) cm tall. Stems not often branched, but if branched, generally branched above the base; some larger plants with 1 side branch from base; stems erect, racemose to corymbose, wiry, green, floccose, becoming reddish-brown and subglabrous in age; internodes to about 1.3 cm long. Leaves alternate, entire to pinnatifid, mostly ascending, older (lower) sometimes spreading, filiform, 9–29 mm long, green, but often with a darker reddish tip, becoming reddish-brown in age, younger leaves floccose, older leaves subglabrous, primary axis width about 0.5–0.75 mm, apex aristate; lower leaves entire, upper entire to 3-lobed, lateral lobes arising from proximal

third of leaf, 2–7 mm long. Inflorescence capitate, with 1–21 or more heads; heads terminating branches, sometimes also present in axils below the terminal head, 5–7 mm long and 2–7 mm wide excluding the tips of the bracts, floccose, and somewhat densely so near the base, with about 3– 9 flowers (axillary heads sometimes with only 1 flower). Bracts entire to pinnatifid, ascending, 5–19 mm long, the tips exceeding the calyces, green, tips sometimes reddish, floccose, more densely so near the base, glandular, apex aristate; entire to 3-lobed, the lateral lobes arising from proximal half of bract, 1.5–7.0 mm long. Calyx (4–) 5.5–6.25 (–7) mm long, sepals with a green tip, light green toward base, floccose, margins hyaline, apex aristate, the proximal two-thirds fused into a tube, lobes unequal to subequal, length difference within a flower 0.7 mm. Corolla narrowly funnelform, actinomorphic, sometimes appearing asymmetric due to interactions of the corolla lobes with the calyx lobes or bracts, (5–) 5.8–6.9 (–7) mm long, only the corolla lobes exserted from calyx, corolla sinuses sometimes proximal to calyx lobe tips; tube 2.9– 3.4 mm long, about half of the total corolla length, white, glabrous inside; throat 0.8–1.3 mm long, nearly symmetric, white to cream; tube plus throat (3–) 3.7–4.7 (–5) mm long; lobes elliptic, tip acute to slightly cuspidate, not always spreading widely when open, 2.0–2.4 mm long, varying in length within a flower by 0.0–0.1 mm, about one third of the total corolla length, 0.9–1.2 mm wide, white to very pale blue, often with a few lavender streaks on or near veins. Stamens included 0.2 mm below sinus to exserted 0.5 mm above the sinus, 1.7 mm or more shorter than the lobes, attached 1.1–1.6 (–2) mm below the sinuses, the insertion distance varying within a flower by 0.0–0.2 mm; free portion (1.5–) 1.75–2.0 (–2.5) mm long, to base of corolla 4.0–4.9 mm long, equal to subequal, the length varying within a flower by 0.0– 0.3 mm; filaments (1.25–) 1.3–1.9 (–2) mm long, the length varying within a flower by 0.1–0.3 (–0.6) mm, filaments straight, white to cream; anthers (0.3?–) 0.8 mm long, 0.5 mm wide, cream, broadly elliptic to slightly ovate, versatile, sagittate. Pollen cream-colored, average grain diameter 34 mm. Pistil 4–5 mm long, exserted or included about the same amount as the stamens, glabrous; stigma lobes (0.25–) 0.4–0.5 mm long; style (2.5–) 2.75–3 mm long; ovary 3-loculed, at anthesis about 1.5 mm long and 0.75 mm wide, with 9–14 ovules total, or 3–5 per locule. Capsule about 3–4 mm long, 1.25–2 mm wide, tan, with 2–4 seeds per locule. Seeds about 1.0–1.5 mm long, 0.7–1.0 mm wide, tan to light brown, angular (Fig. 57–62 [Color Plate 1]; Gowen 2013; S. De Groot, unpubl. data). (De Groot 2015).

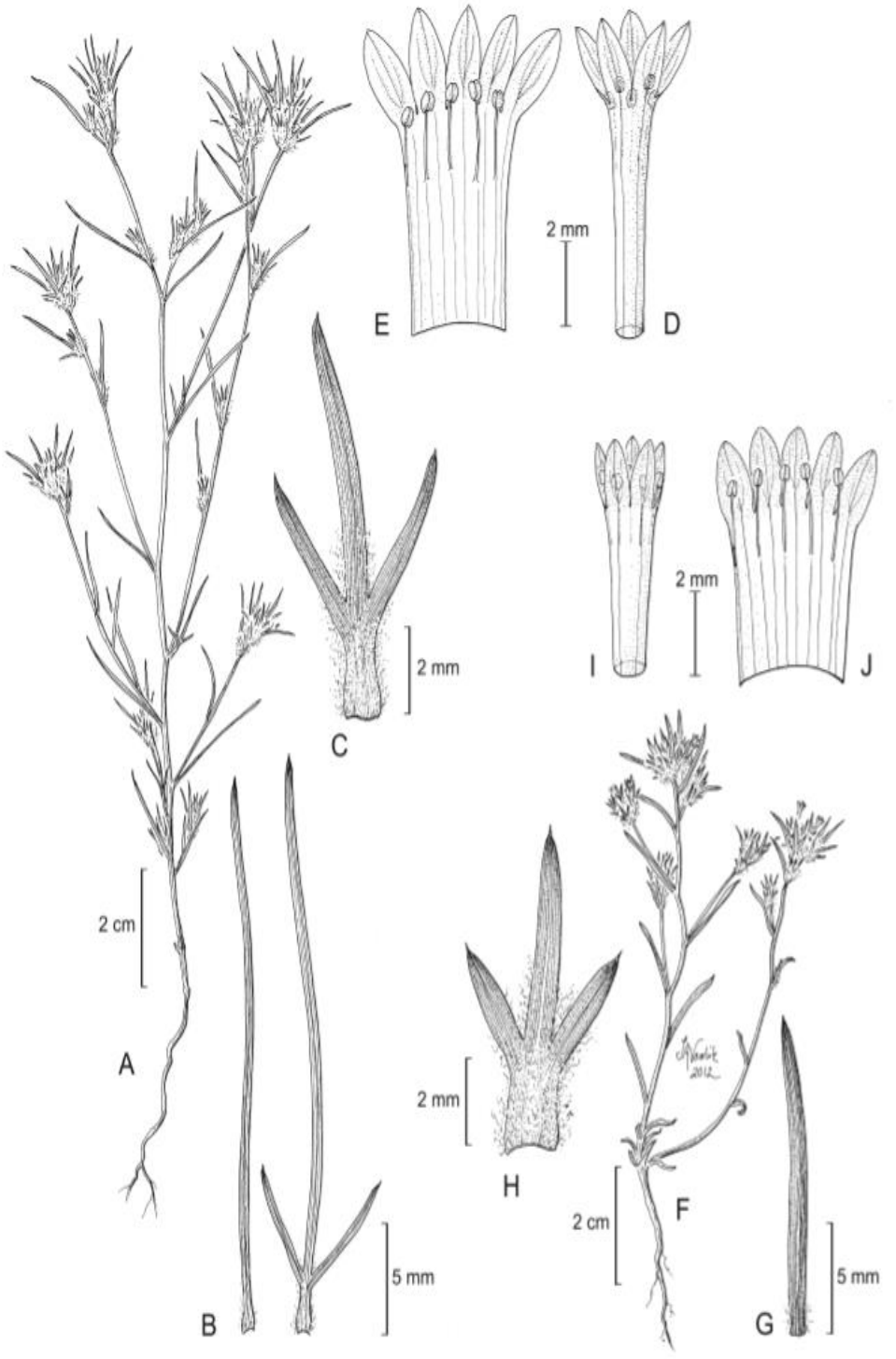

FIG. 1. (A–E). *Eriastrum ertterae*. A. Habit. B. Leaves. C. Bract. D. Corolla. E. Dissected corolla. (F–D). *Eriastrum rosamondense*. F. Habit. G. Leaf. H. Bract. I. Corolla. J. Dissected corolla.

Fig. 3- Pictorial description of *E. ertterae* (A-E) and *E. rosamondense* (F-D). (Gowen 2013)

PHENOLOGY:

E. ertterae begins to flower in late May, blooming until mid to late June. Fruiting occurs in late-June to mid-July (De Groot 2015).

SIMILAR TAXA

Traits that distinguish *E. ertterae* from other similar species were characterized by De Groot (2016) as follows:

"The leaf primary axis of *E. ertterae* is about 0.5–0.75 mm wide, in contrast to the leaf primary axis of *E. rosamondense*, which is about 1 mm wide. The stamens of *E. rosamondense* are exserted 0.4–1.0 mm beyond the sinuses, while the stamens of *E. ertterae* are included or exserted up to 0.5 mm beyond the sinuses. The corolla tube plus throat of *E. ertterae* is 3.7 mm long or longer, while in *E. hooveri* it is 3.6 mm long or shorter. The filaments of *E. ertterae* are 1.3 mm long or longer, but the filaments of *E. hooveri* are 1.3 mm long or shorter. Most plants of *E. ertterae* have more than one ovule per locule—if one locule has only one ovule, other locules in that ovary will usually have two or more ovules. In contrast, locules of *E. tracyi* have only one ovule each—if one locule has more than one ovule, other locules in that ovary will have only one ovule each. Further, bracts of *E. ertterae* are usually 1–3lobed, while bracts of *E. tracyi* are often 3–5-lobed. *Eriastrum sparsiflorum* is noticeably glandular along the upper stems, while *E. ertterae* is not. Corollas of *E. ertterae* are usually smaller (,7 mm long) than corollas of *E. signatum* (7 mm or longer). Stamens are generally more exserted in *E. signatum* (0.8 mm or more) than in E. ertterae (0.5 mm or less), and the style of *E. signatum* is longer (.3 mm) than the style of *E. ertterae* (3 mm or less). *Eriastrumertterae* approaches the range of *E. calocyanum*. These species are easily distinguished by corolla color— *E. ertterae* is mostly white to pale blue, while *E. calocyanum* has bright blue lobes, usually with darker spots at the bases. Furthermore, the corollas of *E. ertterae* are usually less than 7 mm long, while the corollas of *E. calocyanum* are 7.8 mm long or longer."

When David Gowen discovered *E. ertterae* in 2003, he noted that it closely resembles *Eriastrum hooveri,* but with many noticeable differences. *Eriastrum ertterae* has more robust white petals with a bluish tinge or streaks (*E. hooveri* always has uniformly white petals that are smaller in size), its anthers are exserted or at least reaching the corolla sinus lobes (*E. hooveri* has included anthers). *E. ertterae*'s stamens are attached lower in the corolla tube than in *E. hooveri* and therefore it also has longer filaments. The closest known population of *E. hooveri* is also 160 km south of Lime Ridge in the Panoche Hills of Fresno County (Gowen 2013).

Within the past two decades, two populations of *Eriastrum abramsii* have been found nearby at approximately five and eight km northwest of the summit of Mt. Diablo. There are also two historic records of *Eriastrum pluriflorum*, one from the 1800's and the

other from 1933 which are believed to no longer be extant due to development. A small population was also recorded at the Antioch Dunes in 2018. These are the only other known occurrences of the genus *Eriastrum* in Contra Costa County.

It should also be noted that *Logfia gallica* (Asteraceae) superficially resembles *E. ertterae*. But upon closer inspection they are easily distinguished by flowers, leaf morphology, and coloration.

ECOLOGY

HABITAT

The unique geology of Lime Ridge contributes to its botanical diversity. It is comprised of an insular outcrop of sandstone and travertine (almost pure calcium carbonate) (Lyon 1997). The sandstone was deposited as sediment runoff from the Sierra Nevada starting during the mid-Eocene (45 million years ago) creating what is now the Domengine Formation. Hot spring waters rich in calcium carbonate later percolated up through the porous Domengine sandstone. As this water evaporated it left behind calcium carbonate deposits in the form of travertine which originally accounted for a local range of about 2.5 miles long and 0.5 miles wide with a maximum thickness of about 20 ft. The area was also a shallow inland sea before it was uplifted during the formation of Mt. Diablo about 5 million years ago and so fossil shells located in sandstone can be found around the mountain as well (Jerry 2003).

In recent history, the ridge was mined by the Cowell Lime and Cement Company starting in 1908, primarily on its northern and western slopes (Larkin 1982). These materials were taken by railroad from Lime Ridge to the iconic Concord smokestacks that were demolished in 2009 to due lack of structural integrity. There they were mixed with clay and fired in a kiln to make ‘Mt. Diablo Cement’ which was then shipped all around the Western United States. Years of exploitation of the ridge’s travertine and sandstone deposits led to pollution complaints from residents because of kiln particulates and factory emissions. Labor, as well as environmental issues, led the factories to close in 1947.

The extent of the adverse effects that the mining operations had on habitats and plant species is unknown. It is plausible that colonies of rare plant species, including *E. ertterae,* once occurred in areas that were excavated during mining activities. Today, there is a drastic contrast between vegetation on the ridge that was untouched versus areas that were mined. Formerly mined areas are dominated by weedy European annual grasses, whereas the untouched portion of the ridge is dominated by either oak savanna or chaparral (Fig. 6 & 7).

Lime Ridge is one of the few remaining stands of chaparral left within the city limits of Walnut Creek (City of Walnut Creek 2018). The ridge is dominated by chamise (*Adenostoma fasciculatum* var. *fasciculatum*), black sage (*Salvia mellifera*), and Mt. Diablo manzanita (*Arctostaphylos auriculata* [CRPR 1B.3]), making it a unique and rare subset of the *Adenostoma fasciculatum-Salvia mellifera* Shrubland Alliance as characterized by *A Manual of California Vegetation* (Sawyer et al. 2009). Blue oak (*Quercus douglasii*) savanna is the other dominant vegetation type on the untouched portion of the ridge. Several other rare plants occur within these two vegetation types on Lime Ridge including big tarplant (*Blepharizonia plumosa* [CRPR 1B.1]), Hall's bush-mallow (*Malacothamnus hallii* [CRPR 1B.2]), Mt. Diablo helianthella (*Helianthella castanea* [CRPR 1B.2]), Lime Ridge navarretia (*Navarretia gowenii* [CRPR 1B.1]), Mt. Diablo fairy lantern (*Calochortus pulchellus* [CRPR 1B.2]), and Jepson's coyote thistle (*Eryngium jepsonii* [CRPR 1B.2]).

E. ertterae is typically found in a very specific habitat that consists of compacted barren calcareous soil in ecotones between chaparral and grasslands or in open areas within shrublands (Fig. 4, 5, 12, 17, & 18). The soils it occurs on are compacted and sandy with low nutrients and organic matter content. It is found exclusively on what the NRCS defines as rock outcrops of xerortherent association (soil mapping symbol is Re) (Soil Survey Staff 2019). Ortherents are soils within the order of entisols that have formed due to erosion and the prefix *xer* denotes a xeric climate of formation which are specific to Mediterranean climates. In Contra Costa County, this mapping unit averages 50% rock outcrops and 30% xerortherent soils that receive between 20-25 inches of rain per year.

Eriastrum ertterae occurs between 190-280m in elevation (De Groot 2015), on relatively flat slopes where it remains free of competition with no clear preference to aspect. Though vegetative cover is low in these barrens, it often occurs with other plant species such as hollyleaf navarretia (*Navarretia atractyloides*), which is the best native plant indicator of suitable habitat for *E. ertterae*. Upon searching for new populations around the ridge, *N. atractyloides* was observed growing only in areas that appear to be suitable for *E. ertterae*.

The other species commonly found in suitable habitat are non-native species, such as tocalote (*Centaurea melitensis*), red brome (*Bromus madritensis* subsp. *rubens*), soft chess brome (*Bromus hordeaceus*), narrowleaf cottonrose (*Logfia gallica*), hare barley (*Hordeum murinum* subsp. *leporinum*), and nit grass (*Gastridium phleoides*).

Fig. 4- The lone *E. ertterae* individual at the transmission tower site (colony B).

Fig. 5- Picture of the barren ecotones in colony A. Between chaparral and grasslands is where *E. ertterae* can commonly be found growing.

REPRODUCTION BIOLOGY

No work has been done to examine pollinator interactions with *E. ertterae.* The only pollinator study done on a species within the genus utilized *E. densifolium* subsp. *sanctorum* (Dorsett et al. 2001). Researchers found that while numerous species of native bees, beeflies and hummingbirds pollinated this taxon, seed viability was not necessarily tied to pollinator numbers. Comparing pollination syndromes in *E. ertterae* with *E. densifolium* subsp*. sanctorum* is potentially problematic, given that *E. densifolium* subsp*. sanctorum* has exerted stamens 2.8-5.2mm past the sinus lobes of the corolla. This degree stamen exertion greatly exceeds that of *E. ertterae,* and the two species occur in a radically different habitats and locations (De Groot 2015).

ASSOCIATED SPECIES

Based on my field work, associated native species that are found within the plots of *E. ertterae* include *Navarretia atractyloides, Salvia mellifera*, *Adenostoma fasciculatum*, *Arctostaphylos auriculata*, and coastal sagebrush (*Artemisia californica*). Non-natives found include *Centaurea melitensis* (establishing dominance in barren ecotones, particularly in the northern area of the ridge), *Bromus madritensis* (subdominant in certain barrens), *Bromus hordeaceus* (present along margins of plots, sometimes within), *Logfia gallica* (present in all plots but not in overwhelming numbers), *Hordeum murinum* subsp. *leporinum* (present along margins of plots), ripgut brome (*Bromus diandrus)* (present along margins of northern EO plots), scarlet pimpernel (*Lysimachia arvensis*) (present along margins of northern EO plots), nit grass (*Gastridium phleoides)* and silvery hairgrass (*Aira caryophyllea*).

DISTRIBUTION

Preliminary work to identify potential and existing locations of *E. ertterae* was completed through examination of CNDDB records and discussions with David Gowen. There are two element occurrences restricted to Lime Ridge Open Space in Walnut Creek, separated by less than half a mile, as the crow flies (Fig. 8). As previously documented, the northern EO (EO 1) was known to have two colonies while the southern EO (EO 2) consisted of a single colony. However, during fieldwork in 2018 I located a third colony within the northern EO (colony D, Fig. 10, & 11).

Lime Ridge Open Space is owned by the City of Walnut Creek and is managed by their Open Space Division (Lyon 1997). The area is comprised of 1,226 acres, with 25 miles of established trails in Contra Costa County on the borders of Walnut Creek and Concord (Fig. 8 & 11). The ridge and its unique geology extend northward from Mt. Diablo, but Lime Ridge Open Space is surrounded by development on every side except for its southern end that attaches onto the mountain’s foothills (Fig. 11).

Eriastrum ertterae occurs from 190-280 m in elevation (De Groot, 2015) on hilltops in areas that were not affected by the Cowell Mining operation but are still within the unique geologic outcrop.

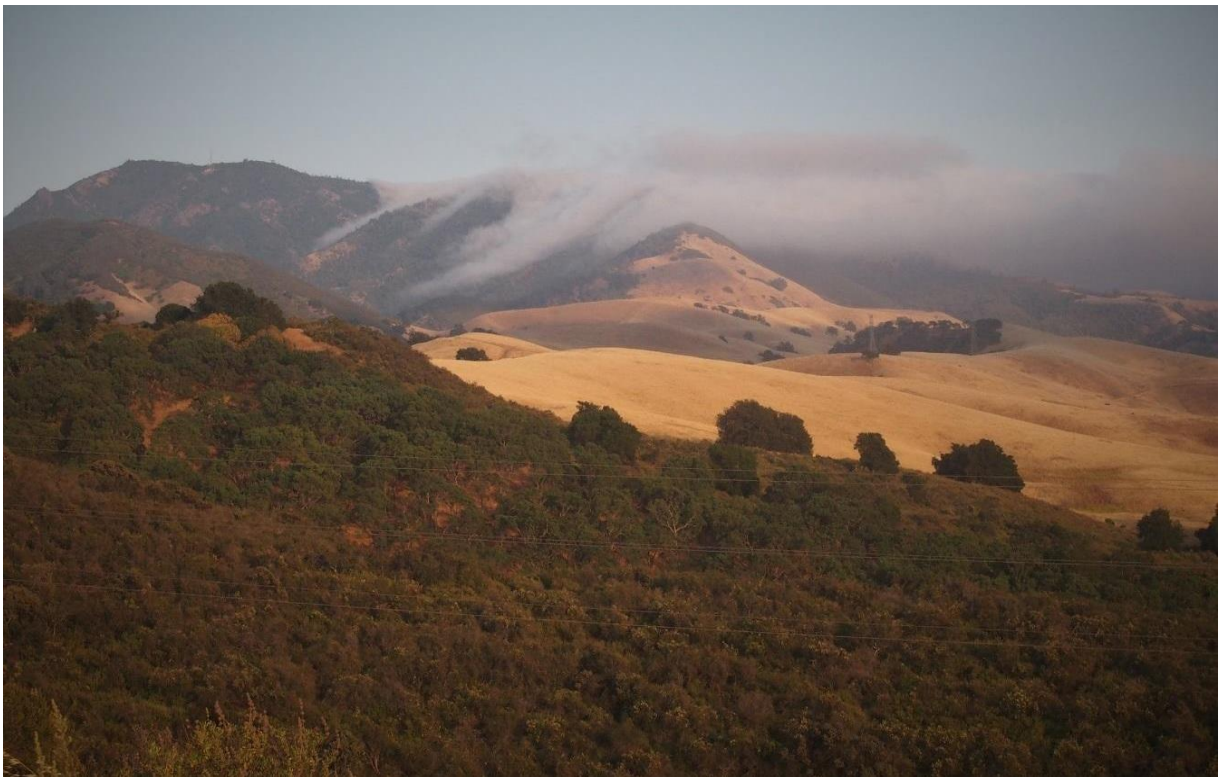

Fig. 6- View of Lime Ridge's chaparral with fog rolling over Mt. Diablo behind it.

Fig. 7- An area on the northern end of the ridge that was excavated during mining.

The two element occurrences (EO 1 and 2) are found on the southern side of the ridge, south of Ygnacio Valley Rd in areas where chaparral vegetation still occurs (Fig 8 & 11). The northern EO (EO 1) hosts three small and scattered colonies (colony B, C, & D, Fig. 11). Colony B is adjacent to the Lime Ridge Trail hiking trail (single track) and the motorized vehicle trail (fire road), next to the PG&E transmission tower (37.931769, -121.985398). Colony C occurs along a non-sanctioned trail just west the Lime Ridge single track trail and north of the Manzanita Trail (37.933142, -121.987986). Colony D occurs uphill from colony C and east of the Lime Ridge single track trail, in an opening in the chaparral canopy (37.933292, -121.987590). The southern EO (EO 2, colony A), is found far off trail with the Ohlone Trail to the west, the Manzanita Trail to the east, and the Paraiso trail just south (37.926158, -121.989652). The Lime Ridge Open Space Map (Fig. 11) shows these colony locations with the trail names for reference (Walnut Creek Open Space Foundation 2016). Figure 9 & 10 give the viewer an understanding of the topography of the ridge and a satellite image of the landscape for reference.

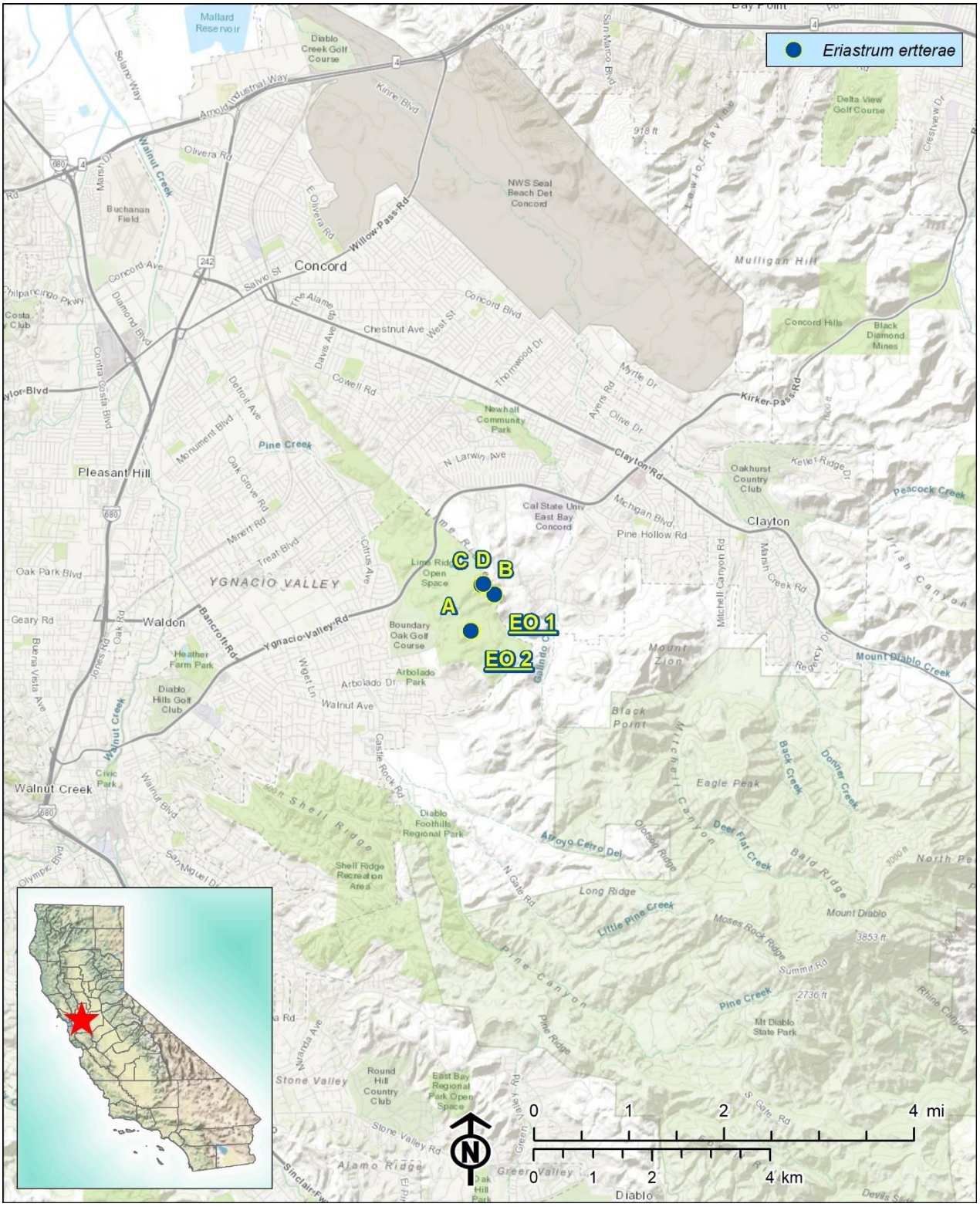

Fig. 8- Lime Ridge Open Space shown in reference to its location within the state of California and the city of Walnut Creek.

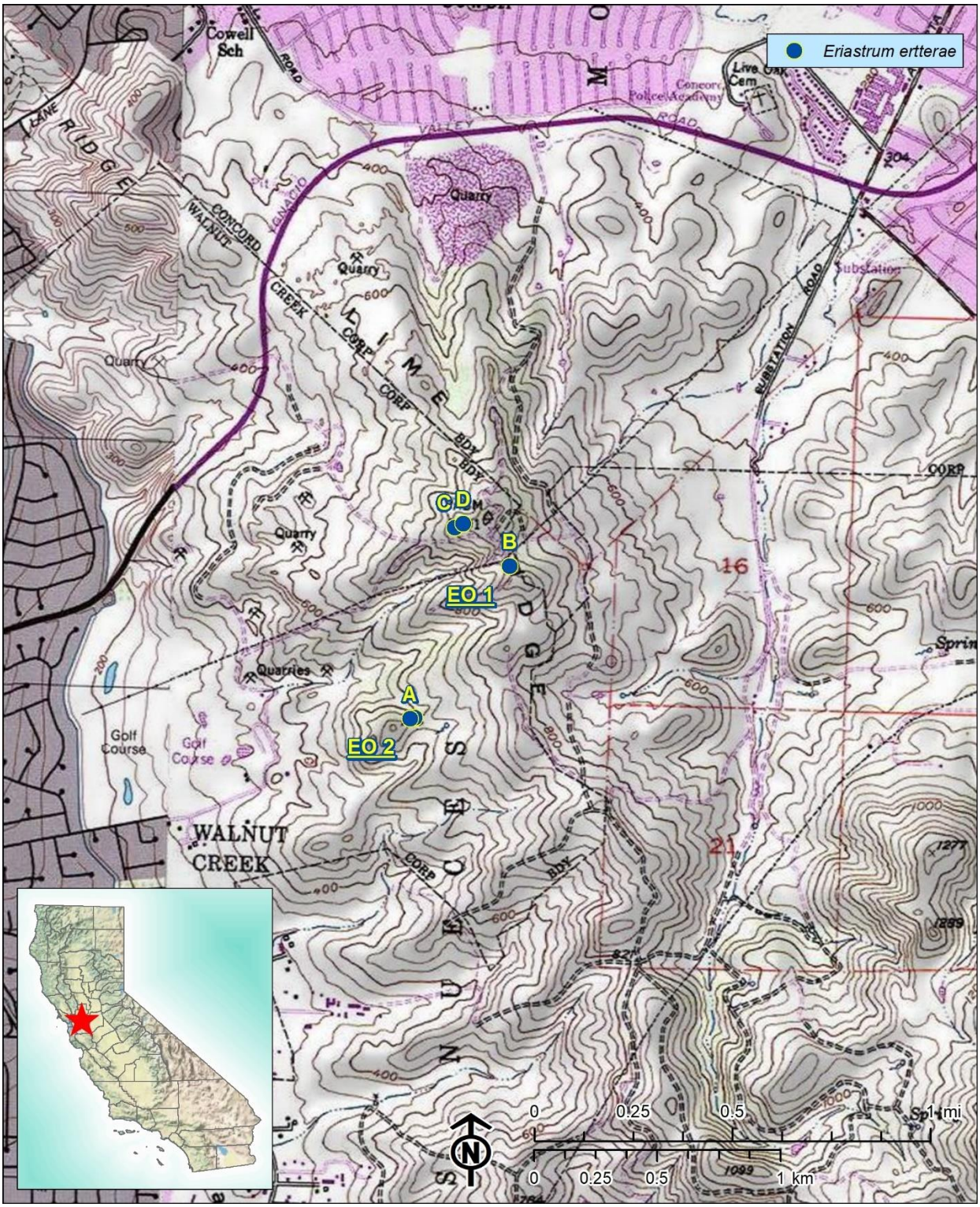

Fig. 9- A topographic map provides a reference for the terrain found throughout Lime Ridge Open Space and where colonies are found.

Fig. 10- Satellite images showing where the colonies are located throughout Lime Ridge Open Space and the extent to which chaparral vegetation is found on the ridge.

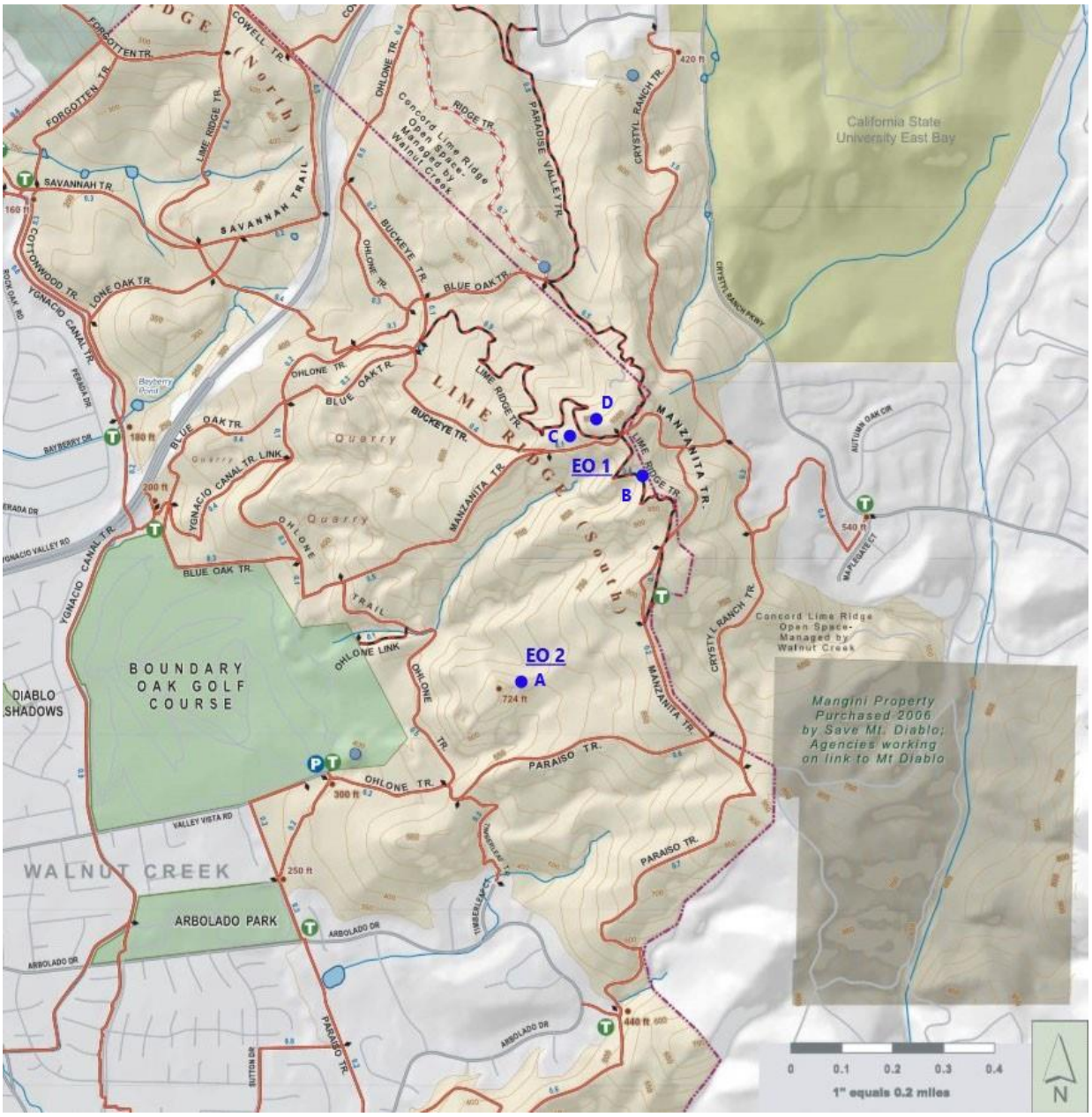

Fig. 11- Trail map with element occurrences and colonies A, B, C, & D noted in dark blue (Walnut Creek Open Space Foundation 2016).

ABUNDANCE

In 2018, the combined area of all *E. ertterae* colonies amounted to 17.16m² with a total population of 1,297 individuals (Table 1). This is a very small area roughly 4.15 x 4.15m that is split into 4 separate colonies. The southern EO (EO 2, colony A) was the largest and covered a total area of 10.81m² with a population of 1,147 (Table 1). The northern EO (EO 1) totaled 150 individuals in 3 small, scattered colonies (colonies B, C, &D) that totaled 6.35m² (Table 1).

I first surveyed *E. ertterae* on May 20, 2018, to observe its phenology. All individuals were in bloom or just about to bloom, so on May 21st I surveyed the Southern EO (EO 2). I separated this occurrence into two plots for counting due to a small stand of *Salvia mellifera* that divides the population into two stands by a distance of 5 or so feet.

The contiguous quadrat method was used for conducting the census using a ½ m^2 rectangular quadrat to quantify the species' area of occupancy and two tape measures were used to record plot size (Krebs 1999). The longest side of the plot ran from east to west (Fig. 12). The quad was laid on the northwestern edge of the plot to begin and rotated end over end, moving from west to east. Once the entire row was surveyed, I returned to the northwestern edge of the plot and moved the quadrat a half meter south to survey the next row.

On May 23, 2018 the northern EO's census was conducted (EO 1). This population is far smaller than the population of the southern EO and therefore a quad was not necessary for accurately counting the individuals. Tape measures were used to measure the area of the plots and then individuals within the area of occupancy were counted. Approximately 20 hours were spent looking for new colonies. A third, new colony, was located (colony D) but it did not constitute a new EO because of its proximity to the other two. Subsequent unsuccessful searches for more populations were made on June 6th, 12th, and 18th. On July 12, 2018, the last visit to the ridge was made to collect seed for the Regional Parks Botanic Garden and to photograph fire damage that occurred during the first week of July from a fire that broke out on the northern end of the open space. This fire came within about 10m of burning the newly discovered colony.

TABLE 1: CENSUS DATA-

Occurrence	**Number**	**Area**
Southern EO (1)	1,147	10.81m^2
Northern EO (2)	150	6.35m^2
Total	**1,297**	**17.15m^2**

TRENDS

Regular population counts have not been conducted for *E. ertterae*. In correspondence with David Gowen, he noted that population numbers appear to be decreasing and site conditions, particularly for the northern EO (1), have deteriorated since he first described the species. The fire that occurred on the ridge in 2018 gave hope to finding new EO's in subsequent years due to the presence of additional habitat

openings, but nothing has been found. Upon visiting the populations in 2019 and 2020, I observed that the population numbers appeared to be lower than when I conducted the census in 2018. David Gowen also visited the ridge during these years and commented that the population numbers appeared to be the lowest he had seen since describing the species. Since the listing process has begun, nothing has been done to address habitat degradation and site conditions in the northern EO are not improving.

This is having negative effects for other rare species found on the ridge as well. David Gowen described *Navarretia gowenii* from Lime Ridge at the same time as *E. ertterae*. Upon visiting the ridge for the past three years, both he and I have been unable to find any individuals of this species. Due to the same forces that are promoting habitat degradation for *E. ertterae*, this species is possibly extirpated. It has been documented in only one other location, but this has not been confirmed with herbaria collections.

KNOWN OCCURRENCES

Southern EO 2 (EONDX – 42749)

The southern EO (2) contains a single colony, Colony A (CNDDB 2018). During surveys, this population was divided into two plots. It occurs far off trail compared to other occurrences and can be approached best through the valley just north of the hill it occurs on by heading east, off of the Ohlone Trail, just south of the Ohlone Link junction (Fig. 11). The precise coordinates for the EO are 37.926158, -121.989652.

Colony A- This colony totaled 10.81m² with a total population of 1,147 individuals during the 2018 survey. These were surveyed in two plots a few feet from each other and separated by a small group of *Salvia mellifera* bushes, the coordinates presented above represent this bush (Fig. 10). The western uphill plot had 1,027 individuals and the eastern downhill plot had 119 individuals. A single individual was also found growing about 5 meters up the hill from the main population occurring at 37.926124, -121.989864. This population occurs between chaparral and blue oak savanna growing in compacted soils that are largely free of other species (Fig. 5 & 12).

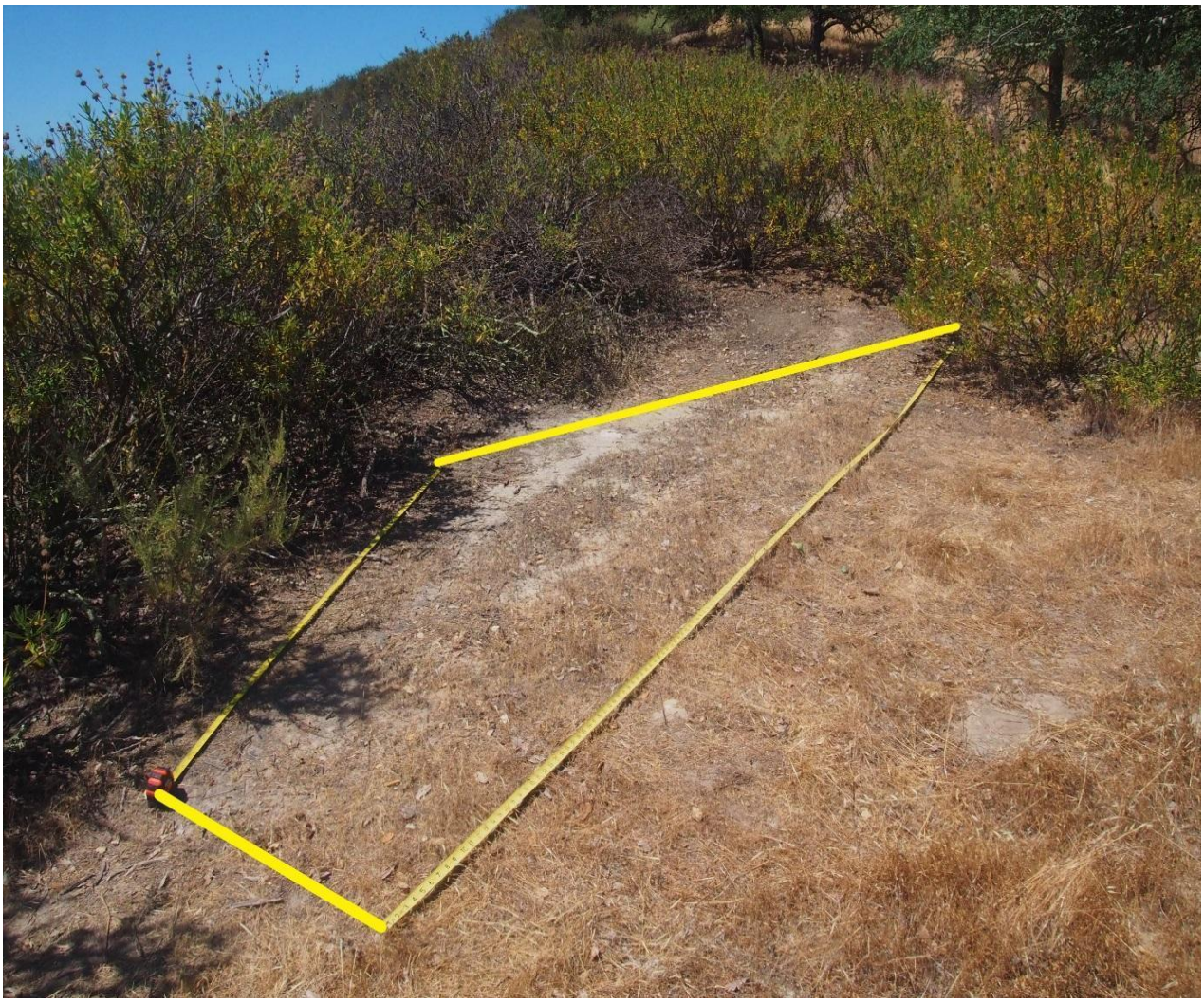

Fig. 12- Picture of the southern EO's (EO 2, colony A) largest sample plot of *E. ertterae,* totaling 1,007 individuals. The upper right-hand side of the plot is the northwestern corner.

Northern EO 1 (EONDX – 42748)

The Northern EO contains three colonies (B, C, and D) (CNDDB 2018). All of these colonies can be accessed via the Lime Ridge Trail and are located either on the trail or not far from it (Fig. 8). One is located on the trail around a transmission tower, just off of Lime Ridge Trail and along a fire road (colony B, Fig. 13,14, & 15). Another colony is found just west and downhill of the Lime Ridge Trail after you cross the junction of the Manzanita Trail heading northwest (colony C, Fig. 16 & 17). It is on the south side of an illegal trail made by hikers in three stands only a few feet from one another. The final, newly discovered colony is found 20 meters uphill and east of the junction for the illegal trail off of the Lime Ridge Trail in an open barren within chaparral (colony D, Fig. 18).

Colony B- A single individual was found in 2018 in the intersection of two trails (Lime Ridge hiking trail and the transmission tower fire road) with the precise coordinates being 37.931769, -121.985398 (Fig. 4 & 15). None were found here in 2019 or 2020. In communications with David Gowen, this population historically has a few hundred individuals spread over a few dozen meters in open areas and on the side of the trails (Fig. 10 & 13). There has been extensive disturbance in the area and PG&E have used the open barrens surrounding the tower where *E. ertterae* once grew to dispose of brush for fire clearance (Fig. 14).

Fig. 13- Picture of the fire road and transmission tower at colony B where *E. ertterae* once had a much larger population along the margins of the trail.

Fig. 14- Photo of the PG&E brush pile at colony B, looking west. This brush pile is about 3 meters long, 1 meter wide and 1 meter tall. The transmission tower is to the left but out of view, the trail seen in the background is the access fire road.

Fig. 15- Colony B, the site of the single *E. ertterae* in 2018, circled in red. The transmission tower is found 10m north (behind me in this photo).

Colony C - This colony is adjacent to a non-sanctioned trail and the coordinates are 37.933142, -121.987986 (Fig. 10 & 16). It has three separate stands that are divided by no more than a few feet of invaded territory that is not hospitable to *E. ertterae*. These three areas are listed from upslope(east) to downslope(west): (1) 0.47m², 6 individuals; (2) 1.85m², 46 individuals (Fig. 17); (3) 0.65m², 41 individuals. In 2018, the junction off of the Lime Ridge hiking trail was closed off with brush piles to prevent bikers and hikers from using the trail (Fig. 10 shows this trail via satellite images).

Fig. 16- The non-sanctioned single-track trail at colony C. *E. ertterae* can be found in the ecotone on the left side of the image.

Fig. 17- Barren open area, home to the largest stand of colony C.

Colony D - This was newly discovered in 2018 and occurs uphill from the colony C, just east of the Lime Ridge hiking trail (Fig. 10 & 11). Its total area is 3.37m² with 56 individuals and the precise coordinates are 37.933292, -121.987590. It occurs in an open barren area that is a break within the chaparral habitat, but *C. melitensis* is establishing in the area, threatening to extirpate it (Fig 18). The highest density of plants within this occurrence is in a subtle wash where invasive species have not yet established, seen in Fig. 15 on the upper right-hand side. The left side of the image shows thick stands of *C. melitensis* which is becoming the dominant species. Only scattered individuals of *E. ertterae* can be found in this area.

Fig. 18- New *E. ertterae* colony found in 2018(colony D).

ATTEMPTS TO LOCATE ADDITIONAL POPULATIONS

During all eight visits to Lime Ridge, attempts to locate new occurrences were made. During those efforts one new population was found in the northern EO (EO 1), though it isn't considered a new EO due to its proximity to other colonies. With over 20 hours of exhaustive searching no other populations were located. The 2018 fire did not produce conditions in which any new populations were discovered. The boom and bust of annual populations could also lead to future satellite populations to be discovered on the ridge. Since being formally described and published in *The Jepson Manual* (Baldwin et al. 2012), the species has not been reported in any other areas. Lime Ridge Open Space is 1,126 acres (Lyon 1997) but only 78.3 acres of this land has the unique xerorthorent soils on which it occurs (Soil Survey Staff 2019). Considering the geologic history of the travertine/limestone formation that is unique to the ridge, it is therefore unlikely to be found elsewhere.

THREATS

Threats to this very narrowly distributed species are numerous and compounded by the fact that all known occurrences are located within a single city owned open space that allows multiple uses. Potential vegetation management of an existing utility right-of-way may also extirpate one of the EOs. The significant threats to the species discussed below and include Open Space Recreation, Utility Right-of-Way Management, Fire Management, Population Size, Limits on Range Expansion, and invasive,

Open Space Recreation:

By far the most immanent threat to all colonies is from open space recreation activities, mainly hiking and mountain biking. Many trails have been built in the open space with some, though not all, allowing mountain biking. However, many in the local mountain biking community ignore signage meant to exclude mountain bikes from some trails. Additionally, members have built, or are in the process of building, illegal mountain bike trails and jumps. Some of these illegal trails are located near colonies of *E. ertterae* (Fig. 16). When examining the different populations within the two EO's, two of the three colonies in EO 1 occur in areas that have foot or bike traffic (colonies B & C). Therefore, certain types of mountain biking activity are unquestionably negatively impacting the species at certain times of the year.

Upon doing field work during 2018, only a single individual was found in colony B, observations during 2019 and 2020 found no individuals. In communications with David Gowen, when he was describing the species, this colony reliably had a few hundred individuals every year and was the largest of the colonies in EO1. He attributes this decrease to mismanagement of these areas, which has already severely reduced the number of individuals found in EO1. The fact that no individuals have been seen at colony B since 2018's single individual means it is highly likely that this colony is extirpated. One reason this could have occurred is from hikers and mountain bikers use of the trail during sensitive times during the growing season.

Mountain biking on the ridge is the most imminent threat to the species for several reasons. It is common along the ridge for people to illegally build jumps in the trails and also clear brush to build unpermitted trails. Colony B sees regular hiking and biking traffic during its blooming period and trampling is likely reducing the number of individuals that produce seeds, thus exhausting the seed bank. Colony C already has an illegal bike trail adjacent to it that has the potential to impact the habitat (Fig. 16). If mountain bikers were to build jumps, as they have done in other areas of the ridge, removal and alteration of soil could lead to the extirpation of this colony. Additionally, there are many trails closed off by fencing with signs to note that habitat restoration is underway. Most of these have been ignored and some fencing has even been torn down to allow for mountain bikers to pass (Fig. 19). It is common that mountain bikers still use these trails along with building illegal ones through brush to connect different paths along the ridge. This is ongoing and presents a constant threat to both EO's as it is unknown where the next unpermitted project will be established.

Fig. 19- fencing to block off access to a trail that has been removed, likely illegally, and discarded into the chaparral.

Utility Right-of-Way Management:

Maintenance of PG&E infrastructure on the ridge is also a continuous threat to 3 of the 4 colonies. Both the PG&E transmission tower along with the underground gas line that runs along the ridge raise concern over how exactly the company is to deal with managing these three colonies while maintaining its own infrastructure and associated vegetation. The chaparral that the company cleared during 2018 around the transmission tower was clearly piled in an open barren where *E. ertterae* once occurred (communications with David Gowen). This was also a refuge along the trail that didn't see substantial foot traffic (Fig 14). Debris from this work reduces the space available for *E. ertterae* to grow. Upon visiting the ridge in 2019 and 2020, the brush pile was still present in its original location, reducing the chance that any previous seed bank might be able to revitalize the withering population. PG&E has also removed a mature *Quercus agrifolia* tree from under the transmission tower, possibly altering the microclimate of the area. It is also unclear when they are doing maintenance work in this area and their presence could be trampling the few individuals left in this colony. With respect to the underground gas line, maintenance will eventually need to occur. This will likely lead to the use of heavy equipment and will necessitate the removal of soil removal and habitat alteration. This unquestionably will threaten the colonies occurring on top of this gas line and possibly lead to their extirpation (colonies C & D, Fig. 20).

For all aspects of PG&E infrastructure found on the ridge, negative impacts could occur from access roads, equipment staging, pipeline excavation, and vegetation management. Compaction, erosion, and displacement of soil that would occur with these activities could extirpate 3 out of 4 known colonies and associated seed banks, putting this species in imminent jeopardy. Negative impacts have already occurred at what was once the largest colony in this EO, steps need to be immediately taken to protect any individuals that occur in this area of the ridge from these or any additional threats.

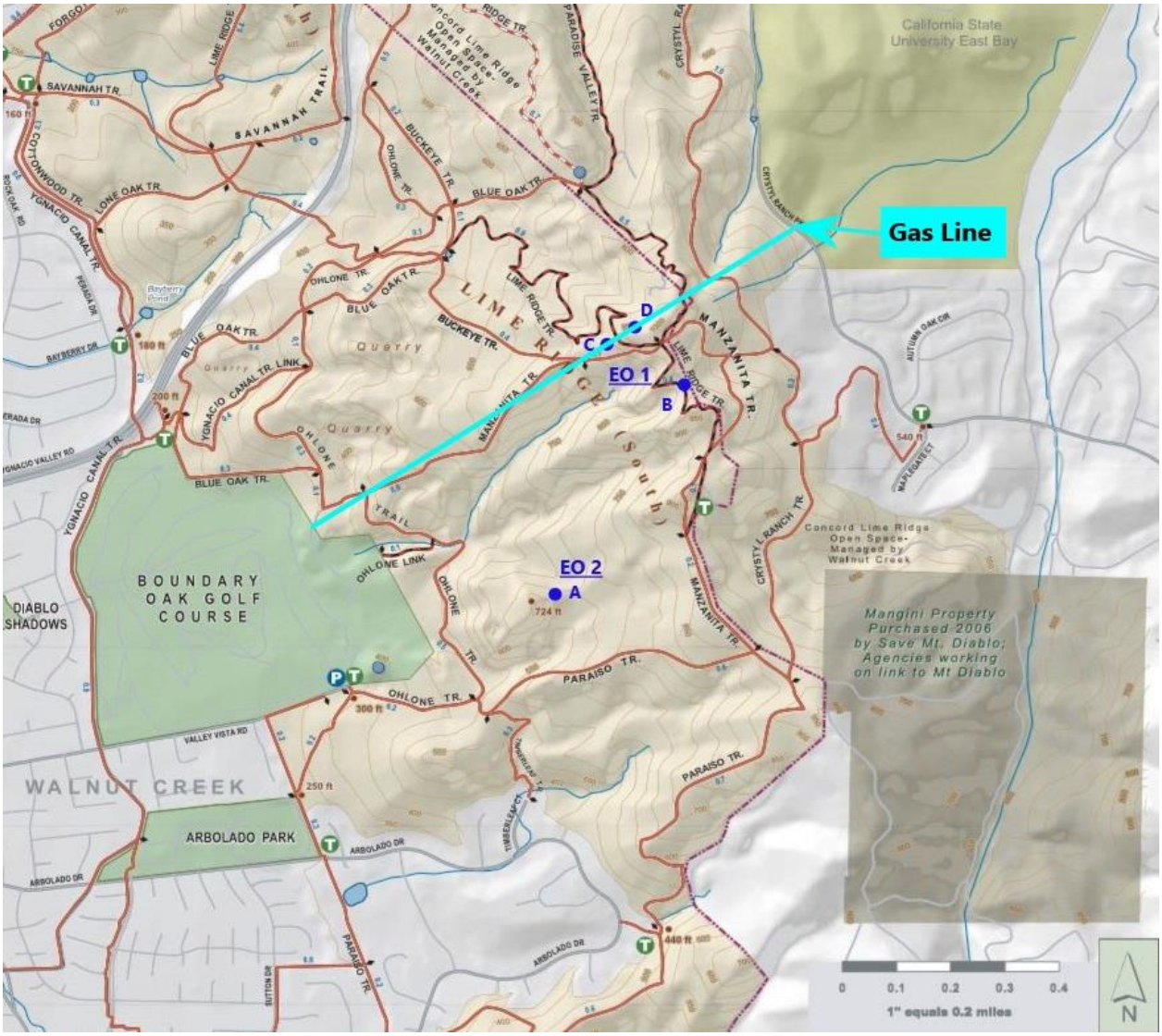

Fig. 20- This is an altered version of Fig.11's trail map documenting the approximate location of the PG&E gas line (Walnut Creek Open Space Foundation 2016). This line runs under EO 1's C & D colonies.

Fire Management:

Lime Ridge Open Space is bisected by Ygnacio Valley Road which is a perennial ignition source of fires during the fire season from vehicle sparks and cigarettes. Fires originating from the road shoulders are common and routinely spread within the open space (Fig. 21). Due to nearby residential subdivisions, fire suppression within the open space is a priority. During the Valley Fire in 2018, a fire break was constructed within 10m of the newly discovered Colony D. In the event of another fire, misplacement of equipment and clearing of brush represents a threat to all colonies. It is also unclear how fire and disturbance affect the species, but research on *E. hooveri* does however indicate that it does not respond well for two years following disturbance (Hinshaw et al. 1998).

Fig. 21- Photo of 2018's Valley Fire, looking north from the highest point on the ridge and the southern edge of the burn.

Population Size:

The incredibly low number of individuals found during the census suggests that genetic diversity could be a problem for the recovery of this species. This can lead to a reduction in reproductive fitness and limited ability to adapt to environmental changes, further increasing the risk of extinction. If the species is self-incompatible, having a population size large enough to maintain genetic integrity is essential for the survival of the species and the number of individuals at this current time is likely not enough to do this.

Limits on Range Expansion:

While there are other barren areas around the open space, the percentage of viable habitat that occurs on the calcareous substrate is minimal. Much of this substrate has already been mined and the areas that are left intact along the ridge are rare (Fig 10). This is also a soil substrate that does not occur elsewhere in the area, suggesting these rare conditions are the only areas where it can persist. This is compounded by the fact that all these areas are not well connected, and the established colonies are fairly disjunct. Seed dispersal of the species is currently thought to occur by scattering once the seed pods have opened and the plant has died, so long distance dispersal isn't common. This therefore poses an ever-looming threat for the future of the populations if habitat conditions continue to degrade in the few pristine areas along the ridge.

Invasive Species:

When one considers all other threats to the species, competition from *Centaurea melitensis* and other invasive species within the northern EO (EO 1) compounds all of these factors (Fig 22 & 23). It is possible that it will assist in the extirpation of at least one of the two EOs. Examining the long-term repercussions of habitat degradation from invasive species means monitoring the invasion of *C. melitensis* into the barren ecotones and as well as the spread of European annual grasses from adjacent grasslands. Through observations around the northern side of the ridge, *C. melitensis* is creating a monotypic stands within ecotones that would otherwise likely be barren. It is found growing in every colony in EO1, often as the sub-dominant species. It sprouts at the same time as *E. ertterae* and is in flower by the time *E. ertterae* is setting seed. This can reduce the area of *E. ertterae*'s realized niche due to competition. *Bromus madritensis* is another common invader into these areas and can be dominant or subdominant within plots. On the grassland borders of ecotones where *E. ertterae* occurs, once *Bromus hordeaceus, Gastridium phleoides,* and *Hordeum murinum* begin to dominate along the margins of the barrens, *E. ertterae* is out competed. While *Logfia gallica also* tends to be interspersed within the stands of *E. ertterae,* it doesn't appear to be overwhelming the population. Aside from threatening the species through competition, this will increase plant material within the barren habitat and will likely alter soil structure, water availability, and change the way fire will move through the ecotones. If allowed to encroach on other areas suitable for *E. ertterae*, these species will first decrease *E. ertterae's* ability to expand its range and eventually outcompete *E. ertterae* where it currently occurs. This is already occurring in the new colony found in 2018 (colony D, Fig. 18).

Fig. 22- *Centaurea melitensis* forming a monotypic stand in ecotones around the northern EO (EO 1).

Fig. 23- A second large monotypic stand of *C. melitensis* on the northern end of the ridge. This area would have likely been barren prior to invasion.

CURRENT MANAGEMENT ACTIVITIES

In 2008, East Bay CNPS Rare Plant Committee Chairman Heath Bartosh drafted interim management guidelines for Lime Ridge Open Space that stated:

"In the interim management will initially consist of the concept of "Do No Harm" -- that nothing is done in the mapped vicinity of the plants to do any harm to existing habitat, germination, or this year's seedlings.

Guidelines:

- No Parking off roads. Vehicles should remain on established roadways and access roads and should not park or turn-around on vegetated shoulders.
- No Road and trail grading or maintenance until more is known.
- No Pest and vegetation control by any means, e.g. pesticide or herbicide application, hand cutting, string trimmer, mowing, etc. until more is known.
- No new facilities, structures, roads or trails until more is known.
- Avoid off-road and off-trail activities. While we understand the Lime Ridge is open to the public and are not proposing to limit public access, this would mean discouraging off road and off trail use, especially near the fenced communication site at the top of the ridge. Eventually, signage informing that the area supports

rare wildlife and suggesting that visitors should stay on trail may be desirable." (Bartosh 2008)

Upon surveying over the 2018 season, it was clear conditions have degraded since Bartosh (2008) outlined the guidelines. Certain aspects of the plan were questionably adhered to, particularly under the PG&E transmission tower and public access by mountain bikers. Public access needs to be restricted during the growth and flowering of these populations. Funding needs to be allocated towards understanding what disturbance regimes effect this species so that clauses in Bartosh (2008) that reference "until more is known" can be understood for management goals.

POTENTIAL MANAGEMENT ACTIONS

The proper timing and level of disturbance for this species could be a key to helping create a space for it to expand into other areas. Caution, however, should be taken to make decisions based on well-informed, species-specific research. Limiting visitor impacts during the growing season could help increase population numbers along trails. It is also important to consider what can be done to reduce the pressure that invasive species likely pose to suitable habitat. To support the establishment of additional populations, soil tests to determine habitat similarity and to inform the selection of new sites isolated from the public is crucial. The Valley Fire in 2018 provided hope that additional populations would be found in newly opened habitat. Being this was not the case, additional work needs to be done to examine the role that fire plays in this species health.

A past study of *E. hooveri's* response to disturbance may inform management of the habitat moving forward. By examining two sites and implementing different disturbance regimes, it was found that disturbance negatively impacted population numbers for two years afterward (Hinshaw et al. 1998). While genetic work has not been done to see how related the two species are, we can use this knowledge as a basis for a management plan to encourage population growth.

Other suggestions are:

- Develop an MOU that details what PG&E should be doing when performing maintenance on the transmission towers and gas lines. This should also include details about what should be done in the event that a fire break needs to be constructed along the ridge.
- Exclude mountain bikes and access to specific areas on Lime Ridge Open Space. Develop a community engagement and education plan to inform people about why this is essential.
- For the time being, closing off the current trails around the transmission tower during blooming and seed set could work to help boost population numbers.

- For the time being, PG&E should do maintenance work before the species begins to grow. Making sure they dispose of brush away from the populations is an absolute necessity to restore what appears to be a dwindling population underneath the transmission tower.
- Develop a plan to reduce *C. melitensis* on the northern end of the ridge. Selective string trimming and weed pulling around the marginal ecotones for a period of a few years could help to reduce the seed bank. The degree to which it is invading current populations should also be monitored on a yearly basis.
- Work to educate the public about why certain trails are closed and why particular forms of land use (creating new trails, stop moving soil for bike jumps, impact during wet periods versus dry, etc.) are detrimental to population viability.

Fig. 24- *Eriastrum ertterae* in full bloom.

ACKNOWLEDGEMENTS

I would like to thank the East Bay CNPS chapter for their contribution to this work through the Myrtle Wolf Scholarship. It was a crucial step in helping to fund the work for this species to be petitioned. Scholarships like this are essential for students to receive funds for work and it helps to promote the conservation and study of the local native flora.

Special thanks to Heath Bartosh for helping guide me through the process of developing my first listing petition for a rare species, along with helping to edit the final draft of this petition. Additionally, thank you to Aaron Sims, Nick Jensen, Jim Andre and Shannon Still for reviewing this petition, editing drafts and providing feedback prior to submission. Additionally, thank you to the California Native Plant Society for approving this petition to list this rare and endangered species.

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